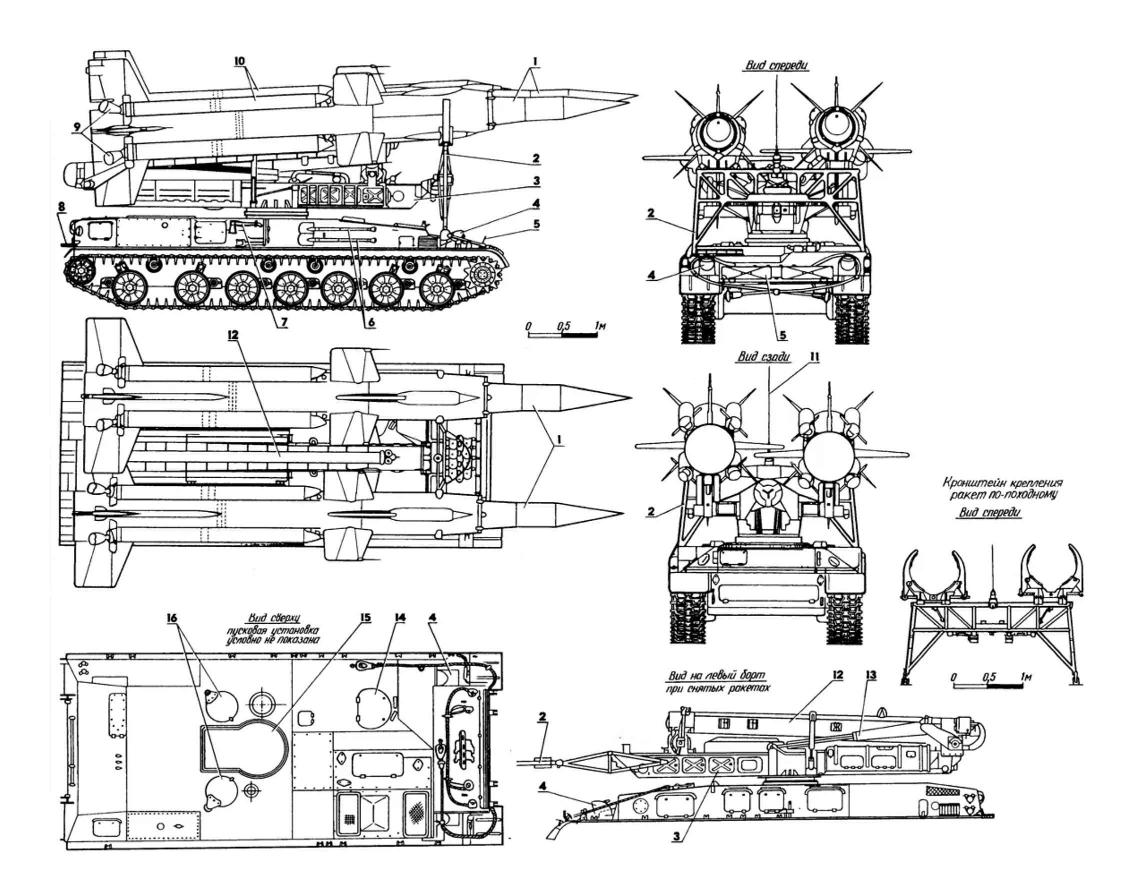
Anti-aircraft missile system 2K11 "Circle". Self-propelled launcher 2P24 and guided missile 3M8.

Greetings. Let's switch briefly to the topic of anti-aircraft missile systems. More precisely, to the Krug 2K11 air defense missile system, which has already been considered for quite a long time on our channel . Unfortunately, due to certain circumstances, it so happened that articles on this topic are published with long time intervals. We will try to prevent this from happening in future comprehensive reviews. Today, on the order of the technical features of two key components of the anti-aircraft system, and imenno- self-propelled launcher 2P24 and surface-to-air missile 3M8 . To anyone interested, you can familiarize yourself with the previous publication on this topic, which was dedicated to the 1C32 missile guidance station (Link to article). The self-propelled launcher of the complex was intended to solve several problems. These are transportation, pre-launch control and launch of an anti-aircraft guided missile of the 3M8 type . The launcher housed two such missiles. The effective development of many weapons systems presupposed a certain interspecific unification. In the case of the 2P24 launcher, it consisted in the use of a lightly armored tracked chassis "object 123", which in turn was a modification of the basic version of "object 105". (better known as ACS SU-100P).



Scheme of a self-propelled launcher 2P24 ZRK 2K11 "Circle".

The development of "object 123" was carried out in the design bureau of the Sverdlovsk transport engineering plant (Uraltransmash). V.M. Pyankov was the lead development engineer . The direct creation of the launcher itself was carried out under the leadership of L. V. Lyuliev in OKB-8 GKAT , later renamed SMKB "Novator" . The development of the 3M8 missile with a command guidance system was also carried out there . In one of the first publications on the Krug 2K11 air defense system, we noted that the development of the rocket took place on a competitive basis and several design teams were attracted to it. However, in the end, we settled on the development of the OKB-8 team.... It is also worth adding that in parallel with the 3M8 missile variant , the 3M10 missile defense system was being developed , which differed in a combined guidance system using a semi-active homing head. But at that time, they could not implement such a system and settled on the 3M8 rocket version . Now in more detail.

1 of 4



Model SPU 2P24M. The author of the model is Boris (Slon2110).

Technical features of SPU 2P24 (KS-41).

The self-propelled launcher had a front-mounted MTO layout . It was located in the front of the case on the right side. As a power plant, a four-stroke V-shaped liquid-cooled diesel engine V-105V was used , which developed a power of 400 hp. from. Its launch was carried out with compressed air, or from the ST-16Melectric starter .

1 of 2





Photo of the ST-16M electric starter.

To cool various MTO units , a special blowing system was used. The transmission is mechanical, step. It consisted of a main clutch, a transmission and steering mechanism, two final drives. Suspension is individual, hydraulic torsion bar. On the left, in front of the car, there was a control compartment where the driver was located. The middle part of the hull was assigned to the fighting compartment. It housed equipment for the preparation, control and launch of missiles, as well as navigation equipment. Data exchange with the 1C32 guidance station was carried out via a radiotelecode line. On the port side, the commander's place was equipped, on the starboard - the operator. Tank intercom R-124 was used for internal radio communication between crew members.... For external communication, a VHF radio station of the R-123Mtype was installed on board .

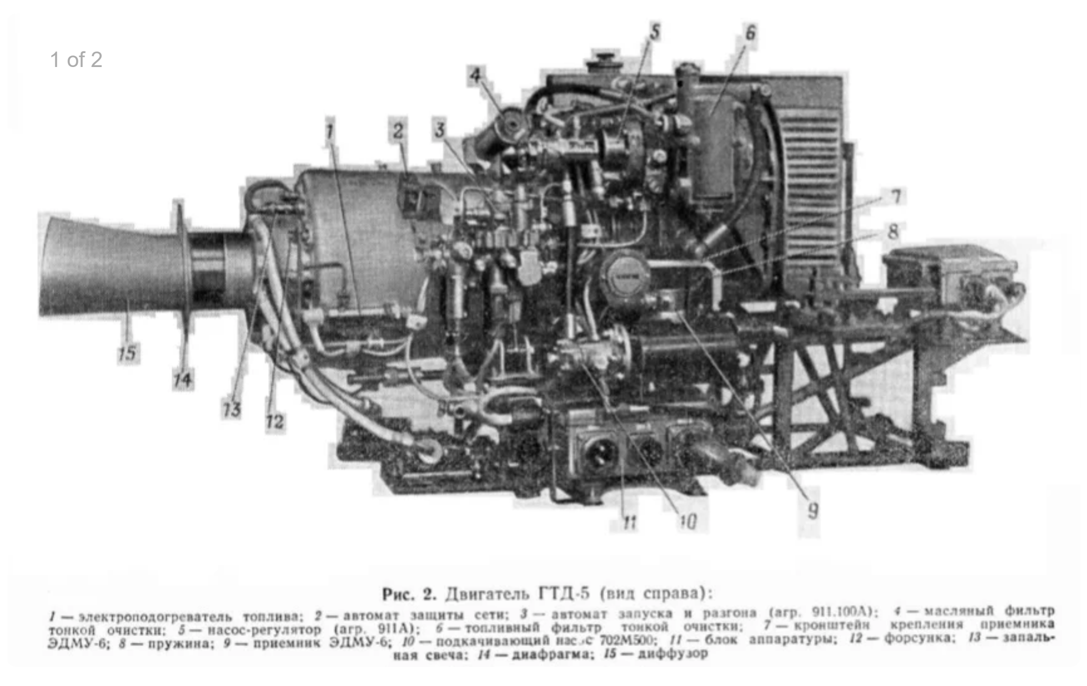


Radio station R-123M.

> *For reference. Tank VHF radio station R-123M . Also known as "Magnolia-M" . It consisted of a transceiver, a power supply unit, an antenna device, a set of cables, a mounting kit for an antenna*

> *device, and a spare parts box . It was a transceiver, telephone, ultrashort-wave station with frequency modulation, made according to a transceiver scheme. The operating frequency range was from 20 to 51.5 MHz. The radio station had 1261 operating frequencies, with a step of 25 kHz. Tuning from one frequency to another was carried out smoothly along the optical scale.*

Above was the artillery part of the installation, which included a special support beam, an arrow and brackets with supports. It housed two missiles. On the march, they were additionally fixed with the help of underwater supports. The missiles could be launched by lifting the boom with guides to an angle ranging from 10 to 60 degrees. The aft part housed the units of the power supply system and the heating and ventilation unit OV-65G . The power unit 1E7 was used as a source of electricity . It consisted of a single-shaft gas turbine engine GTD-5 , with a capacity of 40 liters. from. and the S-20 generator .



Scheme of the GTD-5 engine.

> *For reference. Gas turbine engine GTD-5. It was developed at the Omsk Motor-Building Design Bureau. Chief Designer - Valentin Andreevich Glushenkov . Designed to drive a generator. It was made according to a single-shaft scheme with a centrifugal compressor and a radial centripetal turbine. The main components of the design were: a centrifugal compressor, a rotor of the TC, a combustion chamber, a radial turbine, an exhaust device with an ejector, a gearbox. Among the main systems are the following: lubrication system, air cleaning system, electrical system.*

If necessary, it was possible to operate the generator from the main engine V-105V. The on-board electrical network was made according to a single-wire circuit with a voltage of 24 V. The self-propelled launcher had bulletproof armor, with a thickness of 14 to 17 mm. It is also worth noting that the car was equipped with an anti-nuclear protection system and sound insulation. The fuel was stored in five fuel tanks with a total capacity of 780 liters. The cruising range was up to 360 km. The SPU could reach speeds of up to 63 km / h on the highway and up to 27 km / h on rough terrain.

1 of 4



Photo of self-propelled launcher 2P24.

The total weight of the installation was about 29 tons. There were several variants of machines that had some differences (for example, different front locks for missiles), depending on the modification of the complex.

Technical features of SAM 3M8.

The two-stage anti-aircraft guided missile 3M8 was made according to the "rotary wing" aerodynamic configuration. As noted above, OKB-8 was responsible for its development . Separate nodes and systems were created in related organizations. For example, the on-board equipment (block) of radio control and sighting of the rocket (code 1SB7) was developed at the design bureau NII-20 . A supersonic ramjet engine was created in OKB-670 , which was headed by M.M.Bondaryuk . The general layout of the rocket is shown in the screenshot below.

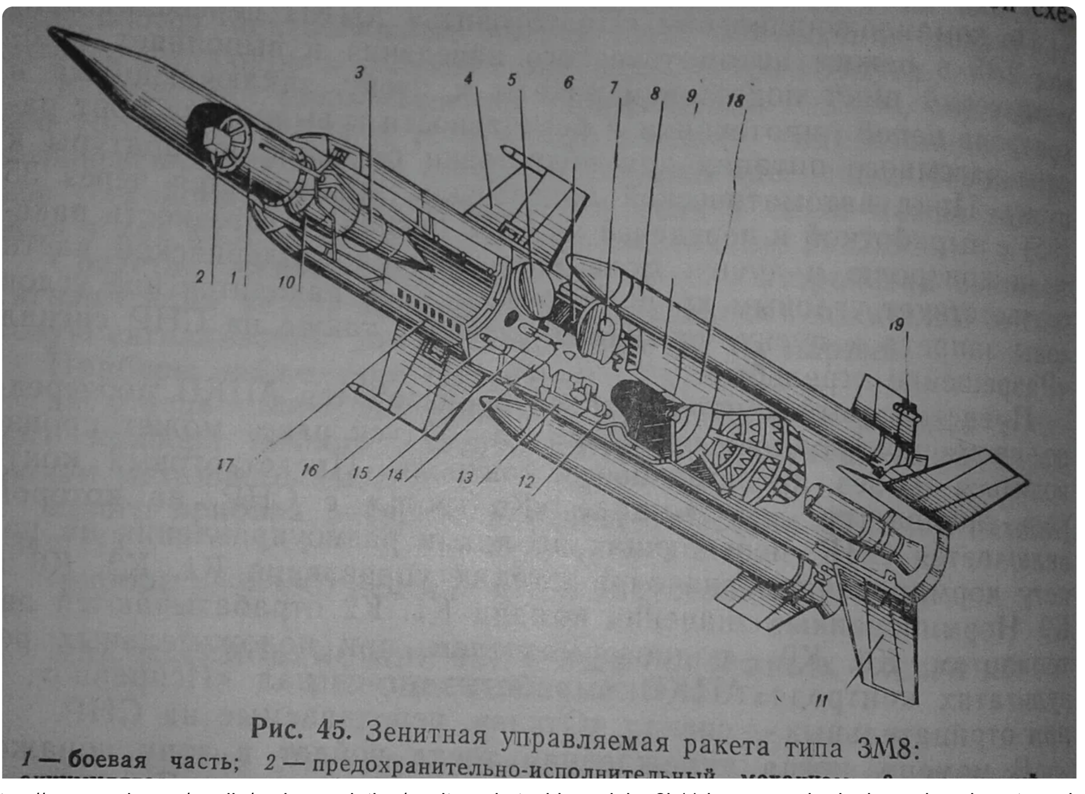


Рис. 45. Зенитная управляемая ракета типа 3М8:
1 — боевая часть; 2 — предохранительно-исполнительный механизм

аккумулятор давления; 4 — крыло; 5 — бак изопропилнитрата; 6 — аппаратура радиоуправления и радиовизирования; 7 — автопилот; 8 — стартовый двигатель; 9 — блок коммутации; 10 — радиовзрыватель; 11 — стабилизатор; 12 — преобразователь тока; 13 — регулятор подачи топлива; 14 — ампульная батарея; 15 — рулевая машина; 16 — турбонасосный агрегат; 17 — топливный бак; 18 — маршевый двигатель; 19 — блок антенн

Scheme of anti-aircraft guided missile 3M8.

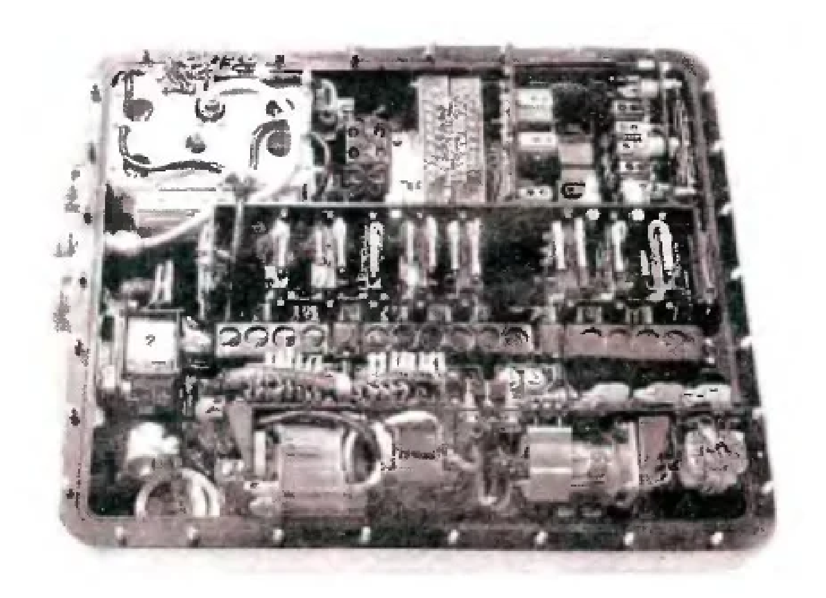
The first stage was the launching accelerators in the form of a solid-propellant rocket engine 3Ts5. There were four of them in total and they were placed on the sides of the structure of the sustainer stage. Each of these boosters was equipped with a 4L11 charge , which consisted of RSI-12K solid ballistic fuel . The charge itself was in the form of a single-channel checker weighing 173 kg. After working out, the starting engines were separated from the rocket. The second (marching) stage was a 3Ts4 (RD-07K) supersonic ramjet engine . I.B. Levanov was the responsible leading designer in OKB-670 .Initially, the layout of the first version of the rocket was supposed to include four autonomous single-circuit RD-07 engines (diameter 350 mm), which were located symmetrically relative to the rocket axis. The engine was supposed to develop an initial thrust of 1650 kgf. However, this scheme was abandoned and switched to a variant with one sustainer engine. As a result, the RD-07K(diameter 850 mm) was developed, which developed four times more thrust than the previous modification. During its creation, new technologies were mastered. For example, the combustion chamber was made of titanium alloy ST-4 , which ultimately allowed to reduce the weight of the product. Flight tests went on for a long time, many problems arose, but ultimately the engine was brought to mind.



Photo of anti-aircraft guided missile 3M8.

Subsequently, variants of the 3Ts4M1 and 3Ts4M2 engine were developed for the upgraded 3M8M1 and 3M8M2 missiles . The initial weight of the sustainer stage was about 1400 kg, of which about 270 kg were for fuel (kerosene T-1 or TS) and 27 kg for monofuel isopropyl nitrate. The latter was used to operate the C5.15 turbo pump unit , which in turn was responsible for supplying the main fuel. Air was used as an oxidizing agent. The kerosene tanks were located on the engine body. In the central part of the rocket were: high-explosive fragmentation warhead 3N11 weighing 150 kg (type of explosive TG-20- 20% TNT with 80% RDX, respectively), a 3E26 radio fuse and a cylinder of an air pressure accumulator. The rotary wing (span 2206 mm) was placed in an X-shaped pattern, it could be

deflected by the steering drive in the range from -28 to + 28 degrees. The sweep along the leading edge was +19 degrees 38 minutes, along the back -8 degrees and 26 minutes. The scope of the stabilizer was 2702 mm, its sweep angle along the leading edge was 20 degrees. The total length of the rocket was 8436 mm, the diameter was 850 mm. The mass of the rocket was 2450 kg.



Radio control unit 1SB7 of the 3M8 missile of the 2K11 "Circle" complex.

Let's take a closer look at block 1SB7 . Specifically, it was carried out by the 32nd laboratory NII-20 , under the leadership of the designer N. Ya. Khitrov . This laboratory consisted of 6 departments, most of which oversaw the development of individual units of this device. For example, the group D. Sergeev engaged instruction decoder ZKRB-3 , and the group A. Zalewskideveloped receiver ZKRB-2 and local oscillator ZKRB-4 . Block 1SB7 wasdesigned to solve the following tasks:

- Reception on the radio from the ground CHP coded control commands SAM;
- Decoding and converting them into analog signals used to guide the missile to the target;
- Formation and transmission of response signals to ensure the sighting of the missile by the guidance station;

The block weight was 31 kg, it included an antenna-feeder device, a receiver, a decoder, a transponder, a command converter and some other nodes. The command line worked in the decimeter range. Request pulses were transmitted along it, and after receiving and decoding, response pulses were formed. A centimeter-range pulsed magnetron was used as a transmitter of response pulses.





SAM model 3M8. The author of the model is Alexander Filatov.

The target was hit by shrapnel and high-explosive action. In the event of a miss, after a certain period of time, the safety-actuating mechanism was triggered, which led to the self-destruction of the rocket.

> ***When writing this article, materials were used from the following sources: https://karopka.ru , http://pvo.guns.ru/ , https://missilery.info/ ,http://www.dogswar.ru , https://techno-story.ru ,http://www.russianarms.ru/ , https://commons.wikimedia.org/ ,http://engine.aviaport.ru , ht https://www.npoelm.ru , book by N. Ya. Vasilin, A.L. Gurinovich. Anti-aircraft missile systems, book by S.I. Petukhov, I.V. Shestov. The history of the creation and development of weapons and military equipment of the air defense of the ground forces of Russia, a book by M.V. Davydov. Years and people. Part two. Anti-aircraft missile systems, book History of domestic radar. Second edition, revised, add. edited by S. V. Khokhlov, the book Gas turbine engine GTD-5. Technical description. Publishing house printing house OMPO im. P.I.Barinova, journal Technics and weapons.***
>
> ***Dear readers, subscribe to the channel, expect new publications.***
>
> ***You can view the full catalog of our articles here***